

The Higgs Discovery and Implications for Theoretical Particle Physics

A visualization of a particle detector, likely the ATLAS or CMS at the LHC. It shows a central collision point with numerous tracks (yellow and green lines) radiating outwards, representing the paths of particles produced in the collision. The tracks are set against a blue, semi-transparent cylindrical structure representing the detector's inner layers. The background is black, with some distant, faint particle tracks visible on the right side.

Marcela Carena
Fermilab and U. of Chicago

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- Discovery of a new type of particle
- Discovery of a new type of force
- Start of a new era for particle physics at cosmology

1960-1967

- SSB
- The mechanism
- the particle
- the model

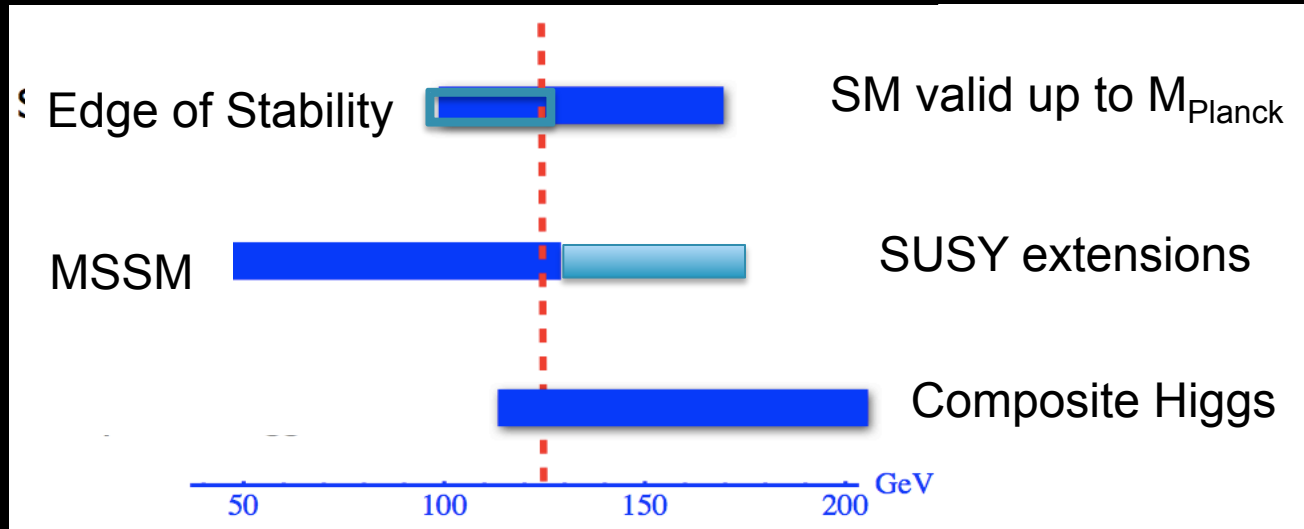


The power of Theory:

A 10B dollar machine built to find the Higgs predicted in the SM

- cutting- edge technology in accelerators and detectors
- decades of work on Higgs Phenomenology (70's – today)
 - precise computation of Higgs production and decays-
 - as well as all other SM processes (backgrounds) -
 - understanding collider signatures

What does a 125 GeV Higgs tell us?



Much theoretical work to support these statements

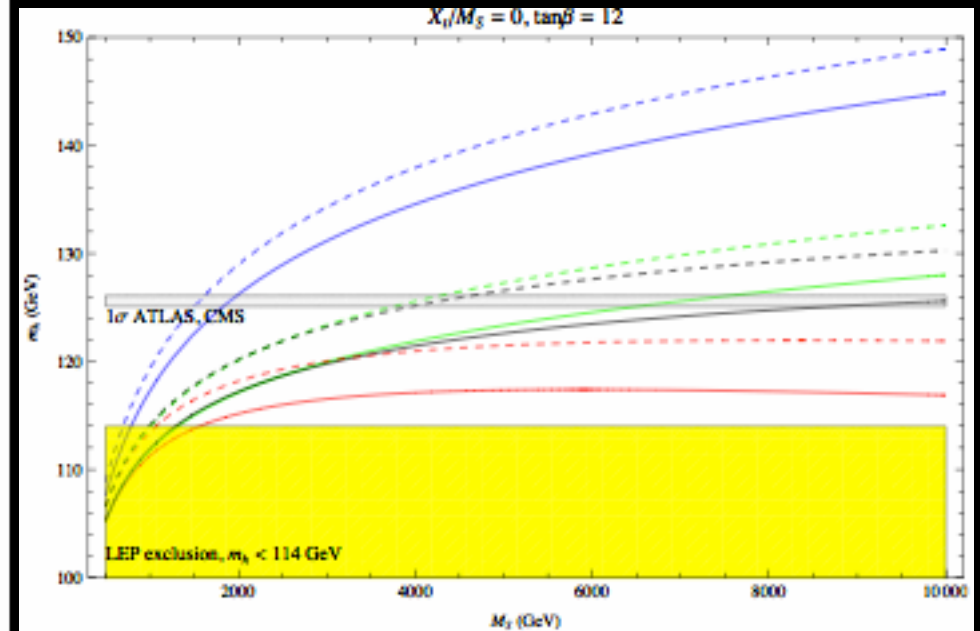
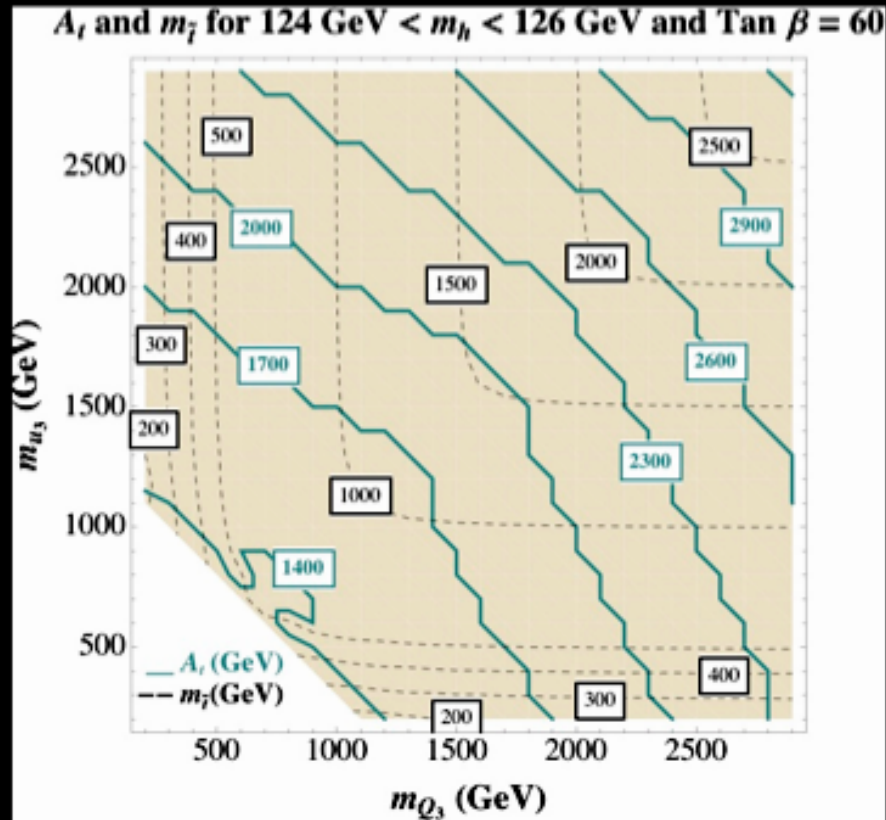
In SUSY:

Multiple Higgs particles necessary: New Higgs bosons at LHC reach or only one SM-like Higgs and the rest heavy
Higgs mass strongly correlated with stops (sbottoms and staus)

In the MSSM: 125 GeV Higgs implies:

Large stop mixing ($A_t/M_Q \sim 1$) but no stringent lower bound on the stop mass
An upper bound on the SUSY scale [10^3 - 10^4 GeV if $\tan\beta$ moderate(5-10)]

Scale of SUSY Breaking

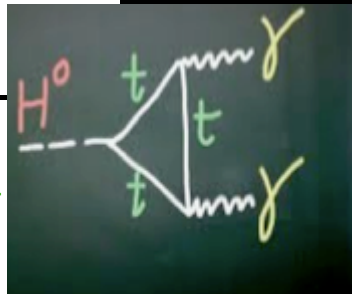
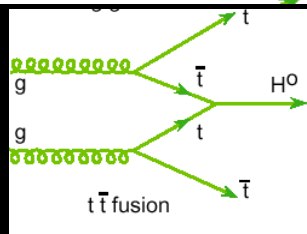
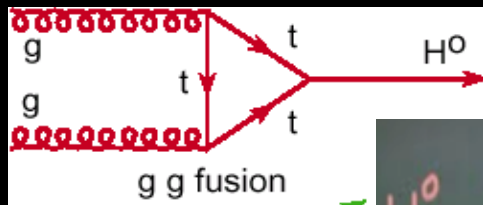


The importance of higher order loops computations

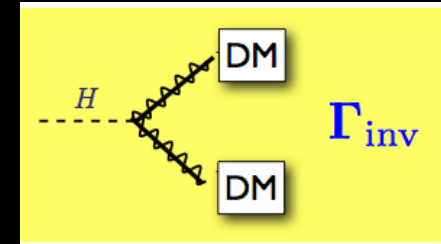
What do the Higgs Production and Decays tell us?

Many different pieces of information

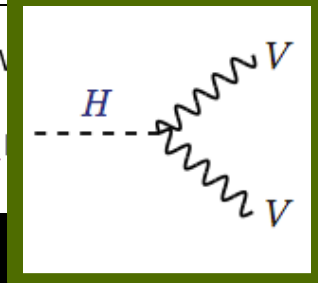
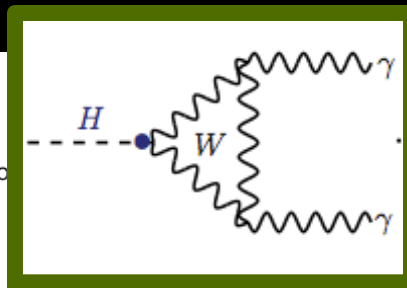
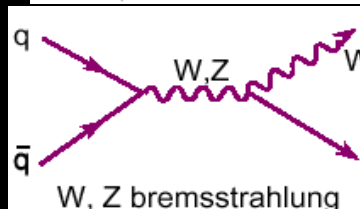
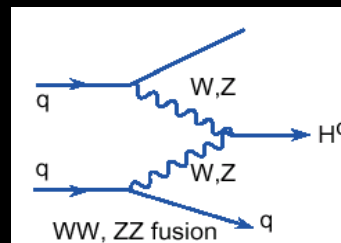
$t\bar{t}H$



also $H \rightarrow b\bar{b}, \tau^+\tau^-$



VVH



Different patterns of deviations from SM couplings if:

- New light charged or colored particles in loop-induced processes
- Modification of tree level couplings due to mixing effects
- Decays to new or invisible particles

crucial info on NP from precision measurements

This is one of the most exciting moments in our field in decades

We expect physics beyond the SM
Where to find it? How to interpret it?

NP can be new particles, new interactions or something else:

- What does the Higgs tells us about Naturalness?
- Is there a Higgs Portal to Dark Matter?
- How does the Higgs interact with neutrinos?
- Is the Higgs triggering baryogenesis?

The funding situation in the US is very challenging and it is becoming difficult to attract and retain young bright minds in the field

Situation elsewhere (some European countries in particular) are putting much more resources in theoretical research

US particle theorists have played a leading role in generating novel ideas in the past many decades and are now playing a crucial role in deciphering the mysteries of our universe from experimental data

Should we try to compete on all areas of theory or concentrate our limited resources on specific ones?